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NOTES AND LITERATURE.

ZOÖLOGY.

Development of Cribrella. — The early development of the starfish Cribrella has been made the subject of exhaustive study by Dr. A. T. Masterman.[1] Segmentation, which is very variable, always culminates in a morula of equal cells. This becomes a blastula, after which gastrulation takes place. The blastopore closes and the archenteron divides into a mensenteron, and an anterior cœlom, and a posterior cœlom. The embryo then escapes as a free ciliated larva. The posterior cœlom becomes the hypogastric cœlom of the post-larval stages. The anterior cœlom becomes differentiated into a central cœlom, and a right, and a left lateral cœlom. The central cœlom becomes the "dorsal sac"; the right lateral becomes the epigastric cœlom; and the left lateral the hydrocœle which eventually gives off five radii. The bilateral larva loses its exact symmetry through an enlargement of its left side. Fixation takes place and the unsymmetrical larva is converted into a young starfish. The larval sagittal plane corresponds to the discal plane of the starfish, the left side of the larva giving rise to the oral, the right to the aboral side of the adult. The bilateral stage suggests a bilateral ancestor similar to Balanoglossus.

Studies of Recent Brachiopoda. — Seldom has a single year brought so many valuable additions to our knowledge of recent Brachiopoda as are represented by the five papers that form the subject of this review. In fact, the only period that at all compares with it is the year 1873, which saw the pioneer embryological work of Morse and Kovalevsky.

The first of these papers, by Dr. Conklin,[2] has to do with the same species '*Terebratulina septentrionalis*' that afforded Prof. Morse

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[1] Masterman, A. T. The Early Development of Cribrella oculata (Forbes) with Remarks on Echinoderm Development. *Transactions Royal Society of Edinburgh*, vol. xl, pp. 373–418, Pls. I–V. 1902.

[2] Conklin, E. J. The Embryology of a Brachiopod, *Terebratulina septentrionalis*, Couthouy. From the Zoological Department of the University of Pennsylvania. *Proc. Amer. Philos. Soc.*, vol. xli, No. 168, pp. 41–76, pls. I–X, 1902.

material for the first investigation ever undertaken of the entire development of a brachiopod, and is a very careful reinvestigation of the early stages of this species by the aid of modern methods of preparation and microscopical technique. The early cleavage forms are found to present considerable variation, commonly in the production of very unequal divisions. These forms do not especially resemble those of the molluscs and annelids, but are more like those of the Bryozoa and Phoronis. Gastrulation is by invagination. The suggestion is offered that certain deep-staining granules seen at the free ends of the gastrula cells are associated with the cilia of the embryo. The archenteron at first possesses one constriction instead of two as in Cistella. The proper orientation of the embryo shows that it belongs to the hypogastric type, an important difference from the Chætognatha with which the Brachiopoda are sometimes supposed to present close relationship. The larva shows three regions,—cephalic, mantle, and peduncular, *which, however, are not true segments.* The mantle at first covers the peduncular region and is subsequently folded up over the cephalic portion. Dr. Conklin compares the embryo of Terebratulina with the trochophore and with the embryos of Phoronis and the Bryozoa, and concludes that the two latter groups and the Brachiopoda should go together in a single phylum, and that their relations with the Chætopoda and Chætognatha are not especially close.

"Observations on living Brachiopoda" by the veteran student of this class, Prof. E. S. Morse,[1] is a timely contribution to a much neglected subject. Occasional references to the habits of brachiopods may be found in various works, as those of Davidson, Œhlert, Woodward, etc., but Prof. Morse's paper contains by far the most extensive and valuable series of observations on the subject yet published. The title, however, does not convey an adequate idea of the extent of the work, for the author has given a large amount of anatomical detail, especially in regard to the mesenteries and perivisceral bands, sense organs, "hearts of Hancock," accessory hearts, etc., which is not confined to observations on the living object. The species chiefly considered are: *Glottidia pyramidata*, *Lingula lepidula*, and *L. anatina*, though in addition observations have also been made upon *Discinisca lamellosa*, and *D. stella*, *Terebratulina septentrionalis*, *Terebratalia coreanica*, *T. minor*, *Laqueus rubellus*, *Hemithyris psittacea*, *H. albida*, and *Dallina grayi*. The tenacity of life in brachiopods, especially in the Inarticulata, has often been a subject of remark. Prof. Morse succeeded in transporting live specimens of Lingula from Japan to this country. "One cannot help," he says, "associating this remarkable vitality of these genera with their persistence through geological horizons from the Cambrian to the present day almost unchanged in character." The freedom and extent of movement of the valves of Lingula, in locomotion and in burrowing, are quite at variance with Hancock's notion of the operation of the muscles, and much more in accord with what one would be led to expect from the general conformation of the valves. The action of the setæ of the anterior mantle margins of Lingula, in forming tubes for the passage of incurrent and excurrent water, is pointed out for the first time, though perhaps slightly anticipated by an observation by Yatsu. Another fact of much interest is the relation between the length of the setæ and the mobility of the valves upon the pedicle. When there is great mobility the setæ are long, and vice versa. Attention is called to the manner in which the ridges (striæ) of the shell of Terebratulina coincide with the setæ, though it is doubtful if there was any such connection as Morse suggests between the setæ and spines of such fossil brachiopods as Productus. The movements of the brachia are described as most graceful and varied. The two parts of the brachia are always moved simultaneously and symmetrically. The "heart of Hancock" is shown to exhibit none of the properties of a propellant organ, and is probably connected in some way with reproduction. This paper is profusely illustrated by outline drawings and one plate of colored drawings, which will be a revelation to those students who have never had the opportunity of viewing living brachiopods.

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[1] Morse, E. S. Observations on living Brachiopoda. *Mem. Boston. Soc. Nat. Hist.*, vol. 5, No. 8, pp. 313–386, pls. 39–61, July, 1902.

The three papers by Mr. Naohidé Yatsu deal with Japanese Lingulas. The development of *Lingula anatina*[1] is a contribution of the highest importance to our knowledge of brachiopod embryology. The earliest stages of development of this type are here detailed for the first time. Even the discharge of the sexual elements is noted. Females with ripe eggs will not discharge them if isolated from the males, so that probably the discharge of the sperm acts as a stimulus to the female to discharge her eggs. The breeding season lasts about one and one half months in Japan — from the middle of July to the end of August. The gastrula is formed by invagination.

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[1] Yatsu, Naohidé. On the Development of *Lingula anatina*. *Journal College of Science*, Imperial University of Tokyo, Japan, vol. xvii, art. 4, pp. 1–112, pls. I–VIII, 1902.

The whole development of Lingula is preëminently direct, the mantle lobes growing over the cephalic region *ab initio.* There is consequently no inversion of the mantle lobes as in Cistella, Thecidium, etc. The embryo is also two lobed instead of three, as in the latter genera, the caudal lobe being absent in Lingula. "The shell is formed at first as a circular lamella folded double along one of its diameters, and is secondarily divided into two valves along the posterior edge." This is in marked contrast with the method of shell origin that obtains among the Articulata. In conclusion, attention is called to the resemblance between the mode of cleavage in Lingula up to the 32-celled stage and that of some species of Phylactolæmata. This is in harmony with the observations of Dr. Conklin above referred to, as is also the fact that in Lingula there is no true segmentation of the embryo.

Mr. Yatsu's paper on the Histology of Lingula[1] gives a detailed account of the several kinds of bodies found in the cœlomic fluid, namely, the blood corpuscles, leucocytes, and spindle bodies. An extended account is given of the latter — their form, occurrence, development, and significance. They are shown to be metamorphosed blood corpuscles, "*a cell whose nucleus has degenerated and whose cytoplasm has turned into a fibrous structure.*" Their function is excretory.

A third paper by the same author[2] deals with the habits of Lingula, and is extremely interesting. These forms live in mud flats which are exposed at low water, and though ordinarily no trace of them can be seen, their presence is sometimes detected by three small holes in the mud. These holes must be evidently produced by the setal tubes mentioned by Morse. The cirri of the brachia, though not the brachia themselves, can be protruded from the front of the shell. The life of Lingula may be as long as five years. Yatsu mentions the extreme tenacity of life in this genus. In one instance an influx of sediment that proved fatal to all the lamellibranchs of the locality had no effect upon the Lingulas. The plates which accompany these three papers by Mr. Yatsu certainly testify to his own and the lithographer's skill. They are models of clearness and beauty.

E. R. C.

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[1] Yatsu, Naohidé. Notes on the Histology of *Lingula anatina* Bruguière. *Journal College of Science*, Imperial University of Tokyo, Japan, vol. xvii, art. 5, pp. 1–29, pls. I and II, 1902.

[2] Yatsu, Naohidé. On the Habits of Japanese *Lingula. Annotationes Zoologicæ Japanensis*, vol. iv, pl. 2, pp. 61–67, 1902.